Some conjectures about the mechanism of poltergeist phenomenon (1)

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**Summary** - Poltergeist accounts concern at least four kinds of strange spontaneous manifestations, such as burning of materials, failures of electric equipments, rapping noises and movements of objects. A simple analysis of phenomenology of these disturbances shows that they might have a common origin, that is, a reduction in strength of molecular bonds due to an enhancement in polarization of vacuum which decreases the actual electron charge. Arguments based on Prigogine' nonequilibrium thermodynamics are proposed, which show how transformations in brain of some pubescent children or young women might be the cause of these effects.

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#### 1 - Introduction

Accounts about poltergeist are common to different ages and different countries around the world. They concern certain strange spontaneous phenomena, such as rappings, burning of fabrics, failure of electric equipments, movement of objects, for which there is no acceptable explanation. Often these disturbances occur in the neighbourhood of one person, generally a pubescent child or a young woman. Believers in spiritism interpret these phenomena as evidence of the presence of supernatural spirits. Misbelievers are inclined to deny their existence. Sometimes this position is justified by the little reliability of persons which witnessed the event. They indeed frequently embroider their accounts with fanciful details.

Nevertheless, in the last few decades some poltergeist occurences have been reported in which qualified persons attended the fenomena. Let us quote the case of Canneto of Caronia, a village near Messina, in which fabrics, electric lines and equipments of various kinds burned unexpectedly in presence of police and fireman officers [1]. A similar episode is that of Falciano of Massico, a village near Caserta, in which curtains, blankets and shirts caught fire without a reason. These events took place only when a 11-year old girl, Isabella, was in the neighbourhood [2]. In year 1947, one of us (P.B.) attended to a different kind of poltergeist event, that is, rapping disturbances taking place in a cinema in Turin (See Appendix A). As for the movement of objects, it is worth quote the case of wine bottles pushed down from the rack, which was attended by the renowned anthropologist Cesare Lombroso in the distant year 1900 [3]. But, there is a case which was validated, besides by public officers, by physicists from the Max Planck Institute. It took place in years 1967-68 in a lawyer's office in

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Rosenheim (Bavaria). Various heavy damages were caused to office machinery and to electric and telephone lines. The focus of these events seemed to be Annemarie, a nineteen-year old employee. The disturbances ceased when she left the office, although witnesses claimed further events took place in her new office. One of physicists of Max Planck Institute, Dr. F. Karger, said "What we saw in the Rosenheim case could be 100% shown not to be explainable by known physics" [4].

## 2 - The phenomenology of poltergeist disturbances.

The first step in order to find a plausible meaning to the previous jumble of disparate events is that of analyzing them separately on the ground of known physics. Since light fire is a quite current job, let consider first the case of burning materials.

a) Burning materials. - Burn of paper, cotton or woollen fabrics is one of the most frequent poltergeist events. Actually, combustion is an oxidation reaction involving atmospheric oxygen, ruled by the velocity law of all chemical reactions, that is, the Arrhenius' law [5]. Dependence on temperature is characterized by the heat of activation  $W_0$ , that is, the energy required to remove bonds in the reacting molecules so allowing the formation of oxygen bonds in the combustion products. By letting A be the Arrhenius' pre-exponential factor, the combustion velocity v(T) is given by

$$v\left(T\right) = A \exp\left(-\frac{W_0}{RT}\right); \quad \left(T_0 \simeq 300 \text{ K}\right) \quad \begin{array}{l} T = 2T_0 \simeq 300^{\circ}\text{C} \\ T = 3T_0 \simeq 600^{\circ}\text{C} \end{array} \right\} ignition,$$

where  $R=1.98\,\mathrm{cal}\,\mathrm{mole^{-1}\,K^{-1}}$ . According to this equation, when T is enhanced from the room value  $T_0\simeq 300\,\mathrm{K}$ , ignitions begin to take place with increasing velocities. For  $T=2T_0~(\simeq 300^{\circ}\mathrm{C})$ , various materials already catch fire, but for  $T=3T_0~(\simeq 600^{\circ}\mathrm{C})$  practically all materials ignite. On this ground, to account for room temperature ignition we are forced to assume that in poltergeist events an enigmatic agent succeeds in decrese activation energy  $W_0$  in such a way that the Arrhenius' law can be rewritten in the form

$$v\left(W\right) = A \exp\left(-\frac{W}{RT_0}\right); \quad \left(T_0 \simeq 300 \text{ K}\right) \quad \begin{array}{l} W = W_0/2 \\ W = W_0/3 \end{array} \right\} ignition.$$

This amounts to admit that the poltergeist burnings are originated by a decrease in the molecular bond strengths.

- b) Failures of electric equipments. Indeed, the previous interpretation easily explains also the failure of electric equipments, sometimes observed in poltergeist events. Actually, insulators utilized in these equipments are made up of rubber or plastic in which chains of carbon atoms are linked by covalent bonds. Weakening in bonding energy reduces the dielectric strength of insulators thus originating their electric breakdown.
- c) Rappings. The most intriguing occurrence is perhaps that of the drumming noises. It could happen that the decrease in bonding energy is great enough that some oxygen molecules in the air are split in two atoms. These

molecules own three degrees of freedom due to their movement in space, two degrees due to rotation around two axes mutually orthogonal and orthogonal to the line joining the atoms and one degree due to anharmonic oscillation of atoms along this line. In total six degrees of freedom. Two oxygen atoms also own six degrees due to their independent movements in space. Owing to the kinetic energy equipartition theorem which allots energy kT/2 to each degree of freedom, the energy owned by these degrees is always 6kT/2 ( $k=1.38\times 10^{-23}\,\mathrm{J\,K^{-1}}$ ) [6]. So, no effect on kinetic energy is expected due to the molecule splitting, while, on the contrary, pressure of oxygen is doubled. A fast increase in pressure could originate a burst and a succession of bursts the drumming noise. Obviously, the same effect is allowed for nitrogen molecules.

d) Moving objects. - As for the strange movements of objects, they can be explained by slow increases in pressure that put strengths on the objects without originating bursts.

It follows that all disturbances could be ascribed to a weakening in molecular bond energies. It is to be pointed out, however, that in disturbances at items a) and b) the energies involved are the heat of combustion of the burned materials and the energy supplied by the power lines, respectively. The poltergeist agent acts only as a trigger. On the contrary, for disturbances at items c) and d) no external source is active so that energy actually derives from the poltergeist itself. In this case, its effect is significant, since bond-dissociation energies are as high as 118 kcal mole<sup>-1</sup> and 225 kcal mole<sup>-1</sup> for  $O_2$  and  $N_2$ , respectively.

# 3 - The effect of quantum fluctuations of vacuum on energy of molecular bonds.

The next step, to get a rational interpretation of poltergeist phenomenon, is that of provide a physical basis to the "enigmatic agent" before quoted. For this purpose, it is to be considered that strength of molecular bonds depends on the actual value of electron charge  $e = 1.6 \cdot 10^{-19} \,\mathrm{C}$ . It, however, is not an absolute constant, as light velocity c and Planck' constant h. Charge eis a "renormalized" constant. Indeed, owing to quantum fluctuations due to the energy-time indeterminacy principle  $\delta w \, \delta t \simeq h$ , virtual electron-positron pairs continuously pop out of the vacuum lasting for a time  $\delta t \simeq h/2m_ec^2$  $4 \cdot 10^{-21}$ s,  $m_e$  standing for the electron mass. Consequently, vacuum behaves like a polarizable dielectric which has the effect of reducing all charges by a constant amount [7]. So charge e is smaller than charge  $e_0$  of the bare electron, that is, electron without the effect of vacuum polarization. On this basis, and taking into account that poltergeist occurences, as burns, electric failures and noises, are always localized in space, we ascribe poltergeist to the appearance of bubbles or plumes in which vacuum polarization is substantially enhanced, so reducing e and consequently the chemical bond strengths. Of course, explain how these perturbations are originated is a rather exacting thing. It is the subject of the next section.

It is worth to point out that the possibility of influence quantum fluctuations of vacuum by introducing external constraints was considered by the Dutch physicist H. Casimir since 1948 [8,9]. It showed that two parallel conducting

plates placed at a small distance attract each other as a consequence of modification of vacuum state in the space between the plates. Successful conclusive experiments on this matter have been recently performed [10,11]. Although Casimir' effect has anything to do with the present problem, it is interesting because it proves that vacuum is indeed modifiable.

## 4 - A possible cause of the enhancement in vacuum polarization.

As said before, poltergeist disturbances often occur in the neighbourhood of a pubescent child or a young woman. These fellows constitute a considerable part of people, so that it is likely that some of them are always present in the nearness of places where poltergeist disturbances happen. Puberty is a modification of the child body which involves various organs, chiefly the brain. To understand how this modification might in rare cases act on vacuum polarization, it is worthy to recall some topics in thermodynamics which, in our opinion, have relation with the matter at issue.

In 1871 J. C. Maxwell investigated the possibility of escape the second law of thermodynamics, that is, of obtain work from thermal energy without utilizing a temperature drop. Maxwell considered a vessel filled of an ideal gas, divided into two equal sections A and B by means of a screen in which a small window was opened. A being, the devil, able to follow the movement of individual molecules operates the window in such a way to allow molecules to pass only from section A to section B. After a determinate time, all molecules are gathered in section B so that, if gas returns in section A flowing through a turbine, work might be obtained. In reality, the removal of gas from section A to section B entails a decrease in entropy. At the beginning, when the window is opened, N molecules of gas are distributed at random between sections A and B. By letting  $P_A$  and  $P_B$  be the thermodynamic probabilities for placing one molecule in section A or B, respectively, initial probability for placing N molecules in the whole vessel is  $(P_A P_B)^N$ . Likewise, final probability is  $P_B^N$ . Taking into account Boltzmann' law on entropy, we have

$$S_B - S_{Ran} = k \log P_B^N - k \log (P_A P_B)^N = -Nk \log P_A,$$

 $S_B$  and  $S_{Ran}$  standing for final and initial entropy, respectively. But this entropy decrease is not allowed by the second law of thermodynamics. It has been shown, in fact, that, in order to gain the information for control the window, the devil must increase the entropy of gas precisely of the same amount of the decrease obtained (often called negentropy) [12]. Consequently, no free decrease of entropy is possible and the Maxwell' devil is exorcized.

Let us turn now to a different subject, that is, the chirality (mirror-symmetry) of proteins. Proteins consist of chains of thousands of amino acids in which one carbon atom  $C^*$ , referred to as asymmetric carbon, is joined by four tetrahedral bonds to a carboxil COOH, an amino group  $NH_2$ , a hydrogen atom and a radical R. Protein chains are formed by removal of water molecules from carboxils and amino groups. Owing to asymmetry of carbon  $C^*$ , two mirror forms, right

(R) and left (L), of amino acids are possible as shown in the following figure

(To read this figure, consider  $C^*$  placed on leaf plane,  $NH_2$  and H behind, COOH and R before the plane). This state of affairs mimics that of the distribution of molecules in sections A and B of the previous Maxwell' problem. Indeed, like a molecule can be placed in section A or B, bonds of carbon  $C^*$  can be set in form R or L. Place all molecules in section B or, likewise, set all bonds in form L corresponds to minimum entropy. By letting  $N_b$  be the number of different biological amino acids ( $N_b = 20$ ), entropy of a protein including at random N amino acids of forms R and L is

$$S_{Ran} = k \log (2N_b)^N$$
,

since there are  $2N_b$  choices for each amino acid in the chain. Correspondingly, entropy of a protein including only L (or R) amino acids is

$$S_L \equiv S_R = k \log (N_b)^N$$
.

It follows that an entropy decrease

$$S_L - S_{Ran} = -kN\log 2$$

is obtained when transforming a random protein in a L (or R) chain. But, as before the second law rules out this way of minimizing entropy. Surprisingly, all biological proteins are constituted only of L amino acids. It happens like a devil cleverer than Maxwell' devil operating on protein chirality succeds in violating the second law!

To solve this conundrum, it is right resort to Prigogine' nonequilibrium thermodynamics of open systems, that is, systems not insulated from their environment [13,14,15]. It has been shown that in these systems processes not too far from equilibrium keep production of entropy at the minimum rate. These processes are stationary, that is, systems remain unchanged in time. On the contrary, in case of high irreversibility, systems become unstable and fluctuations are originated which decrease the system entropy until the so-called dissipative structures appear. This phenomenon is referred to as order by means of fluctuations or self-organization in nonequilibrium systems. Of course, this entails that an amount of entropy,  $S_{Env}$ , greater than the decrease produced is thrown in the system environment by means of fluctuations, in such a way that total entropy, of system plus its environment, increases as required by the second law. That is, if

$$\left(\frac{dS}{dt}\right)_{Sus} < 0,$$

then

$$\left(\frac{dS}{dt}\right)_{Env} >> 0, \qquad \left(\frac{dS}{dt}\right)_{Sus} + \left(\frac{dS}{dt}\right)_{Env} > 0.$$

Correspondingly, the first law requires that energy is turned out in the system environment in cases in which self-oganization decreases the energy of the system.

The theory is rather complex and we do not dwell on this matter. Among the various examples of dissipative structures providing evidence about the fitness of this theory, we limit ourselves to quote the oscillating reaction of Belousov and Zhabotinskij [16,17]. It consists in the oxidation of the malonic acid  $COOH.CH_2.COOH$  in watery solution by means of potassium bromate in presence of  $Ce^{+4}$  which acts as an oxidation gauge. In a flat vessel (Petri dish), the dissipative structure appears as a nice pattern of spiral waves in which concentration of reagents is different from that of the unperturbed solution. In Appendix B, a practical recipe is given for producing the reaction dealt with.

The chiral asymmetry of proteins is a clear signature that the organism of human beings is a dissipative structure memorized in DNA, consequence of a slow self-organization process implemented in the course of geological ages (3). However, at birth and in the following years the brain apparatus which rules sexuality is not ready. On this basis, the most conservative hypothesis is that a special self-organization process takes place in brain during years of puberty. This process, very fast as compared with that creating the human being organism, should activate the network of sexual neurons. Electrons in neuron molecules should be engaged in entropy-decreasing fluctuations leading to a dissipative structure. But brain is imbued with the vacuum distribution of electron-positron pairs which fills the space. Consequently, these fluctuations should throw excess entropy  $S_{Env}$  into surrounndig space so enhancing there the density of pairs, that' to say, the vacuum polarization. The enhanced polarization bubbles hypothized in Section 3 should be originated in this way. In rare cases, perhaps much less than one in a million, there are phases in which fluctuations are produced with a rate great enough that the enhanced polarization originates poltergeist phenomena. This process obviously concerns a limited environment of brain, of size perhaps not exceeding some meters across.

## 5 - Final remarks

Altogether, the previous arguments can be summarized as follows. A decrease in entropy (creation of order) in brain of pubescent people throws a greater amount of entropy (disorder) into the brain environment, which, in exceptional cases, originates poltergeist disturbances. In practice, poltergeist is interpreted as a by-product of the entropy increase  $(dS/dt)_{Env}$  expected in consequence of the second law. This interpretation is based on two sound achievements of the past century physics, that is, quantum electrodynamics of vacuum and nonequilibrium thermodynamics.

 $<sup>^3</sup>$ Evidence about the basic role of chirality in control living organism structure is provided by the unfortunate episode of thalidomide drug. It was patented in 1957 as a sedative and hypnotic. Thalidomide is a glutamic acid derivative showing an asymmetric carbon in the glutarimide ring. This chemical is a random mixture of R and L forms. When it was administered to expectant mothers the embryonic development was severely damaged by mismatching between drug and protein chiralities.

To develop further the proposed interpretation, topics about thermodynamics of perturbations in vacuum and of transformations in brain should be considered. We leave this out but consider the important topic of poltergeist energy. In disturbances at issues a and b of Section 2, energies involved, as already pointed out, seem negligible. On the contrary, disturbances at issues c and d require perhaps even some hundred joules. Exceptional transformations in the human brain might supply this amount of energy, but certainly cost in energy is a point which limits the frequency of poltergeist phenomena.

We point out, finally, that the opinion that poltergeist is connected to anomalies in the vacuum state is not new. Actually, physicists D. Radin, head of electrical engineering department at Duke University, assumes that poltergeist movements are repulsive versions of the Casimir effect that can put pressures on objects (see item d) in Section 2) [18]. Indeed, while the attractive Casimir effect is due to a decrease of vacuum polarization, its repulsive version should be ascribed to an enhanced polarization. Consequently, this interpretation agrees with that proposed in Section 3.

# Appendix A

## A poltergeist event in Turin (Spring 1947).

The event I dwell on took place in a cinema in the Turin centre (i.e. cinema "Romano" near to "Castello" place). I watched the first afternoon film presented in this cinema in company with a girl friend. I and my friend took place rather far from the screen, over half the room length. About ten minutes after the beginning of the projection, the room was still almost empty. Nearly one dozen people were gathered near the screen, plus few lonely people scattered at various distances from the screen.

Unexpectedly, a loud drumming noise at a distance less than ten seats beside my seat came to disturb the projection. It looked like anyone hammered rapidly the wooden back of its front seat. But nobody was near the place of the noise origin. After perhaps four seconds, the noise began move swiftly toward the screen, then it came back and so on several times. This troubling noise gave rise to energetic protests of spectators, especially those seated near the screen. These persons, evidently boys, came out with howls and bad words to induce the disturber to stop. All this uproar ceased abruptly after less than five minutes. Then the film projection continued undisturbed while other spectators progressively reached the room. The whole event repeated itself other two times after intervals of less than one hour. But, in the meantime all seats in the room were filled. Consequently, the wooden backs of seats, damped by the occupant spectators, lacked the resonant capabilities of vacant seats. This not least because persons wore coats owing to the fresh season. Evidently the drumming noise was originated somewhere else.

Probably most spectators perceived the strange event as a successful joke organized by some carefree persons. I and my friend, incapable of explaining the drumming noise trick, were bewildered but satisfied with the unexpected free show.

## Appendix B

## The Belousov - Zhabotinskij reaction.

In order to allow a quick start of the reaction, malonic acid is substituted by bromomalonic acid COOH.CBrH.COOH (BMA) according to the following recipe:

Dilute with water to 25 ml. Ferroin oxidation gauge replaces Ce<sup>+4</sup> ions.

Preparation of BMA: dissolve 10.4 gr of malonic acid in 75 ml of ether cooled with ice, add slowly 16 gr of  $Br_2$ . Evaporate the ether and keep 12 hours in dessicator with KOH under vacuum.

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